

MEW, LLC  
3040 Reuben Drive  
Reno, NV 89502  
775 790 1850



## Balloon Boy User Manual

DOC NUM:

**MAN-000117**

Revision Date:

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### 1.0 Introduction

Balloon Boy (BB) is the project name for the GPS tracker and telemetry system targeted for use with high altitude balloon and rocket flights. Balloon Boy Printed Wiring Assemblies (PWAs) contain Electrostatic Discharge (ESD) sensitive components and must be handled in a manner to prevent immediate, delayed or latent damage from ESD. You must practice normal and customary ESD control techniques to insure a long and happy life for the BB PWAs.

The system typically consists of at least two and optionally more systems consisting of one Airborne Package (AP) and one or more Ground Stations (GS). The AP typically transmits digital data to one or more Ground Stations at a rate of one update per second. This data rate can be changed by the end user through configuration software for the respective GPS receiver on the AP.

There are three basic starting configurations for the BB hardware:

1. Balloon Boy Airborne Package using Inventek™ GPS receiver technology with Laird Technologies® 900 MHz, 1 watt RF modem.
2. Balloon Boy Ground Station hardware (no GPS receiver installed and 200 mW Laird Technologies RF modem)
3. Balloon Boy Airborne Package using U-Blox® GPS receiver technology with Laird Technologies 900 MHz, 1 watt RF modem.

### 2.0 Purpose

This User Manual is intended to help the end user with integrating the Balloon Boy hardware with their respective high altitude balloon or rocket projects.

### 3.0 Scope

This User Manual is intended for use by end users who have a need to know the technical details necessary for successful balloon and rocket flights and recoveries using the BB system. This manual is not all inclusive and the author makes the assumption that the end user is completely cognizant of the various technical areas of expertise required for system integration.

The BB hardware requires additional peripheral equipment that must be carefully chosen by the user for their unique project requirements. Some of the additional equipment is noted in the following list:

- Airborne Package GPS antenna and coaxial cable with associated connectors
- Airborne Package RF modem antenna and coaxial cable with associated connectors
- Airborne Package batteries, holders, and power switch
- Ground station Antenna and RF cable assemblies with associated connectors
- Ground Station batteries, holders, power switch and associated alarms or annunciators.

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- Appropriate environmental protection for the AP and GS in the form of a chassis, insulation, housing or project box.

### 4.0 Norms

Safety considerations and Radio Frequency (RF) compliance as referenced in this User Manual are limited in scope to the Balloon Boy system. This section does not address other regulatory requirements of typical balloon or rocket flights such as FAA, BLM, BATF, OSHA and all other federal, State or local agencies. Compliance and permitting with these and any other agencies such as EU RoHS and WEEE is beyond the scope of this user manual and must be addressed by the equipment end user(s) and/or importers.

### 4.1 Definitions

For definition of unfamiliar words, phrases, or terms, please utilize and donate on line to Wikipedia:

<http://www.wikipedia.org/>

### 4.2 Abbreviations and Acronyms

ISO	International Organisation for Standards
BB	Balloon Boy
LOS	Line of Sight
GPS	Global Positioning System
ISM	Industrial, Scientific, and Manufacturing
PWA	Printed Wiring Assembly
PWB	Printed Wiring Board
AP	Airborne Package
GS	Ground Station
FCC	Federal Communications Commission
RF	Radio Frequency
IC	Industry Canada
WRT	With Respect To
RGA	Return Goods Authorization
NMEA	National Marine Electronics Association
OS	Operating System
SAR	Specific Absorption Rate
ESD	Electrostatic Discharge
EOS	Electrical Over Stress

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### 4.3 Safety and Regulatory Information

#### 4.3.1 Safety:

WARNING: This equipment has been approved for mobile applications where the equipment should be used at distances greater than 20 cm from the human body (with the exception of hands, feet, wrists, and ankles). Operation at distances of less than 20 cm is strictly prohibited and requires additional SAR testing.

#### 4.3.2 RF Agency Compliance:

BB Airborne Package and Ground Station contains Laird Technology RF modem under the following FCC and Industry Canada compliance statements/certificates:

United States of America:

Balloon Boy Airborne Package or Ground Station equipped with Laird Technologies AC4490LR-1000  
Contains FCC ID: KQLAC4490

Balloon Boy Airborne Package or Ground Station equipped with Laird Technologies AC4490LR-200  
Contains FCC ID: KQL-4X90200

The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) This device must accept any interference received, including interference that may cause undesired operation.

Canada:

Balloon Boy Airborne Package or Ground Station equipped with Laird Technologies AC4490LR-1000  
covered under IC certificate 2268C-44901000

Balloon Boy Airborne Package or Ground Station equipped with Laird Technologies AC4490LR-200  
Covered under IC : certificate 2268C-4x90200

The BB system is shipped to the buyer configured such that the Airborne Package is a server in broadcast mode (transmitter) and the Ground Station is a client in receive mode (receiver).

The above referenced certifications and approvals are valid when the BB system is used with the following specific antennas or equivalent antennas with equal or lesser gain:

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Laird Part Number	Manufacturer Part Number	Manufacturer	Type	Gain (dBi)
0600-00019	S467FL-5-RMM-915S	Nearson	1/2 Wave Dipole	2
0600-00025	S467FL-5-RMM-915	Nearson	1/2 Wave Dipole	2
0600-00024	S467AH-915	Nearson	1/2 Wave Dipole	2
0600-00027	S467AH-915R	Nearson	1/2 Wave Dipole	2
0600-00028	S161AH-915R	Nearson	1/2 Wave Dipole	2.5
0600-00029	S161AH-915	Nearson	1/2 Wave Dipole	2.5
0600-00030	S331AH-915	Nearson	1/4 Wave Dipole	1
-	Y2283*	Comtelco	Yagi	6 dBd
-	Y2283A-915-10RP	Comtelco	Yagi	6 dBd
-	SG101N915*	Nearson	Omni	5
-	SG101NT-915	Nearson	Omni	5
-				

\* Strictly requires professional installation.

### 4.4 Quality Statement

Balloon Boy PWAs are designed and built with integrity

- using traceable and certified components
- sourced from franchised or authorized distributors
- using licensed and approved design software

Balloon Boy PWAs are NOT, and never will be, designed or revised using pirated software or built by third world child labor using counterfeit components.

## 5.0 Balloon Boy System Technical Data

### 5.1 Environmental Specifications:

Operational Ambient Temperature Range: -40 °C to +80 °C

Storage Temperature Range: -50 °C to +85 °C

Relative Humidity: less than 90% non-condensing

Atmosphere: inert, non-oxidizing and non-corrosive

Do not use in hazardous or explosive environments

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### 5.2 Electrical Specifications:

#### 5.2.1 Power

Supply Voltage input range: 8Vdc minimum, 28 Vdc maximum.

Typical power dissipation:

1.44 Watts Airborne Package when configured for maximum  
RF power, 9600 Baud data rate. No auxiliary load applied.

360 mW Ground Station system. (receive only)

Switching power supply (typical @ 25 °C, unless otherwise noted):

Output Voltage: 3.3 Vdc  $\pm$  2%

Efficiency: > 85%.

Ripple at maximum load current (including 1 amp auxiliary load): < 40 mV p-p

auxiliary load output current: 0 to 1.0 Adc over entire specified ambient temperature range.

#### 5.2.2 Radio Frequency Modem

RF power output:

Airborne Package: 1000 mW Maximum

Ground Station: 200 mW maximum, normally configured as receiver with no transmission

For detailed and complete modem specification reference Laird user manual. A download link to the  
Laird user manual can be found in section 6.1

#### 5.2.3 Typical Performance (AP configured for maximum power)

RF Link LOS distance (12 dBi GS Yagi antenna, 2 dBi AP dipole antenna) :

Observed: 50 Miles

Calculated link path budget (with 15 dB fade margin) 94 Miles

RF Link Distance with AP laying on flat ground with dipole antenna 3 inches above and parallel to ground:

Observed with 6 dBi GS Yagi antenna: 1 mile

Observed with 12 dBi GS Yagi antenna: > 2.2 miles

RF Link Distance with AP laying on flat ground with dipole antenna 1.5 inches above and parallel to ground:

Observed with 6 dBi GS Yagi antenna: < 0.9 mile

Observed with 12 dBi GS Yagi Antenna: > 1.5 miles

The above typical performance numbers were observed in low background RF noise level rural areas.

Congested municipal areas and non LOS conditions will greatly affect (likely reduce) specific individual observed performance.

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### 5.2.4 GPS features, performance, and functionality

Inventek GPS Module:

Off the shelf Customized Firmware on SiRF Star III chipset  
Functional altitude ceiling: 137,795 feet (42,000 Meters)  
NMEA serial output at 4800 Baud, 1 fix per second report rate (port B)  
SiRF Binary protocol at 57600 Baud, (Port A)  
*Reference Inventek documentation for additional data*

U-Blox GPS Module:

U-Blox 6 GPS platform  
Functional altitude ceiling of 164,041 feet (50,000 Meters)  
NMEA serial output at 9600 Baud, 1 fix per second report rate (Port B)  
*Reference U-Blox documentation for additional data*

## 5.3 Mechanical Specifications

### 5.3.1 Board Outline and Mounting Holes

Mounting hole thru diameter: 0.130 inches  
Mounting hole pad diameter: 0.222 inch.  
Mounting holes and pads are suitable for 4-40 socket head machine screws mated with 0.187 inch diameter round standoffs.  
Header J10: 2 x 10 pin header on 0.100 inch pitch grid  
Jumper header: 2 x 9 pin header on 0.100 inch pitch grid

Top side of board requires 0.600 inch clearance and bottom side of board requires 0.500 inch clearance.

PWB Thickness: 0.062 inch

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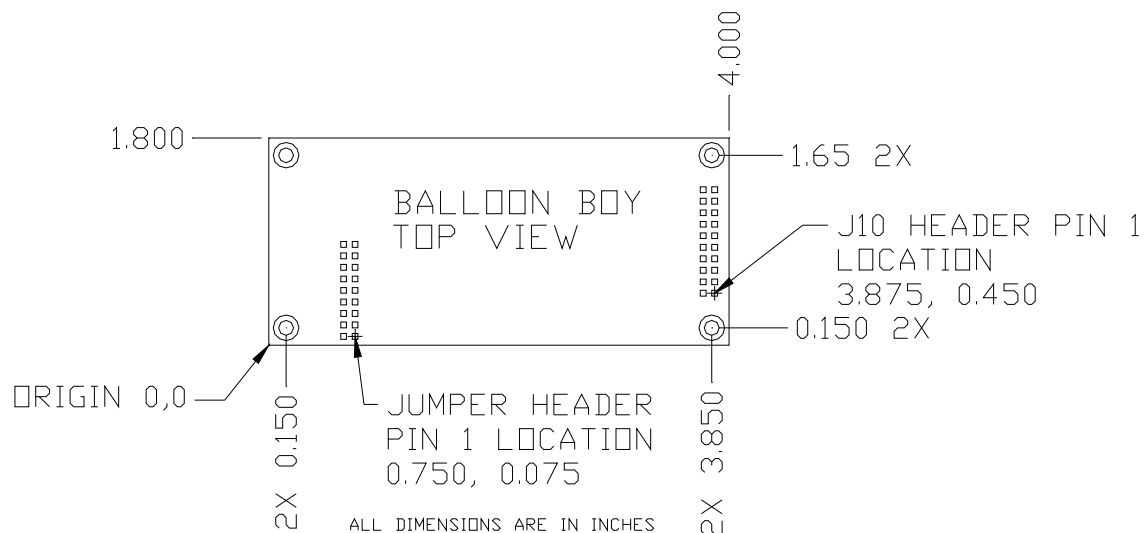


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### Balloon Boy PWB Outline, Dimensions, Mounting Hole, and Header Positions



PWA Weight: < 61 grams



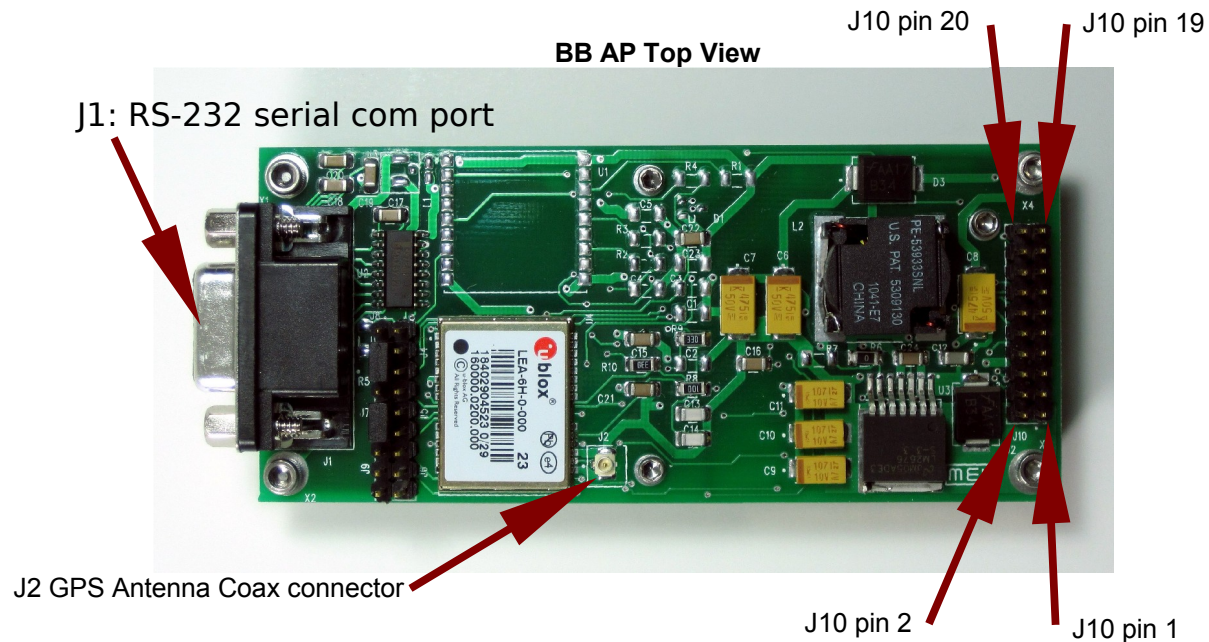


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### 5.4 Balloon Boy Power and I/O connections:



#### Power, Signal, and I/O PinOut

Ref Des	Pin #	Description	Notes*
J1	All	RS-232 compliant serial communications port: female DB9 connector	I/O
J2	All	U.FL connector for active GPS antenna	Coaxial
J10	1,2	Power and signal common	PWR
J10	3	Power down signal: logic 0 = power down, float = power up	1
J10	4	VBB, Backup battery +3Vdc: direct connection to + terminal of lithium coin cell	BU
J10	5,6	Auxiliary Logic Power output: +3.3 Vdc at 1 Amp max current draw	PWR
J10	7	RF in range signal, no signal: → +3.3V    Signal in Range: → 0V	Output
J10	8	RF_DA_Out, Modem analog output signal line	Output
J10	9	RF_AD_In: Modem analog input signal line	Input
J10	10	RF_CMD_Data: float: Modem data mode, 0V: Modem command mode	Input
J10	11	RF_GI1: Modem Generic digital input 1	Input

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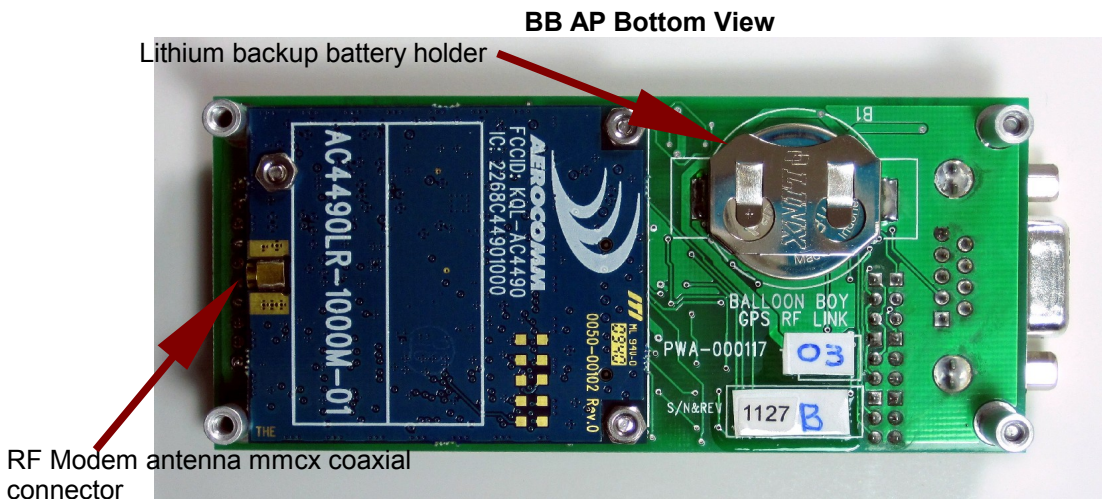
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Ref Des	Pin #	Description	Notes*
J10	12	RF_UP_RST: Modem reset, logic low: modem reset, normally floating	Input
J10	13	RF_TEST: Logic low: Modem test mode, Logic High or float: normal mode	2
J10	14	RF_RSSI: Modem Received Signal Strength Indication	3
J10	15	RF_H_F: Modem Hop Frame	3
J10	16	RF_GO1: Modem Generic digital output 1	Output
J10	17	RF_GI0: Modem Generic digital input 0	Input
J10	18	RF_GO0: Modem Generic digital output 0	Output
J10	19,20	Supply Voltage input: 8 Vdc to 28 Vdc WRT power/signal Common	PWR

**\*Notes:**

1. Power Down Signal line connects directly to switching regulator and must not exceed the voltage range of -0.1 to 6.0 Vdc WRT power/signal common. Power down threshold voltage is a minimum of 0.8 Vdc, typical value of 1.4 Vdc and a max value of 2.0 Vdc
2. Test Mode: pull low with open drain driver, Test Mode at power up forces RF modem to communicate at 9600 baud (8-N-1). Do not apply signal that exceeds 3.3 V logic rails.
3. Reference Laird AC4490 User Manual for detailed functional description.



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### 5.5 Auxiliary Parts List

The following parts list details parts and components needed for integrating BB into a functional Balloon or Rocket project. Listed parts are not all inclusive. Many other functionally equivalent parts are suitable for use. Parts listed here are known to function properly and have previously been used with BB hardware.

Item	Description	Manufacturer	Part number	Vendor/Source
1	900 MHz 6 dBi Yagi Antenna	Hyperlink Technology	HG906YE-NF	L-Com
2	900 MHz 12 dBi Yagi Antenna	Hyperlink Technology	HG912YE-NF	L-Com
3	Active GPS Patch Antenna with U.FL connector	Inventek Systems	ACTPAT254-01-IP	Inventek
4	Active GPS Helix Antenna	Sarentel	SL1206R	Premier Wireless Solutions
5	SMA bulkhead to MMCX coaxial cable, 200 mm length	Embedded Antenna Design	M2MAC-MR-20-SFP	Symmetry Electronics Corp.
6	Type N to SMA coaxial cable , 19 inch length	L-Com	CA-MMNMCN19	L-Com
7	N-male to SMA adapter	Emerson Network	601-29-3840	Mouser Electronics
8	900 MHz dipole antenna	Laired Tech	0600-00025	Mouser Electronics
9	GPS coaxial antenna cable, U.FL to U.FL, 1000 mm length	Hirose Cables	UFL2LP068N1A1000	Mouser Electronics
10	AA Lithium Battery	Energizer Battery	L91	Home Depot
11	CR2032 Backup Lithium Battery	Panasonic	P189-ND	Digi-Key
12	Personal Computer with available serial com port (either real or virtual USB com port) running Windows OS or equivalent	Personal choice compatible with chosen GPS mapping software	-	-
13	RS-232 Serial Cable, 9 pin D-Sub, Male-Female straight thru (not a null modem cable)	Personal choice	-	-

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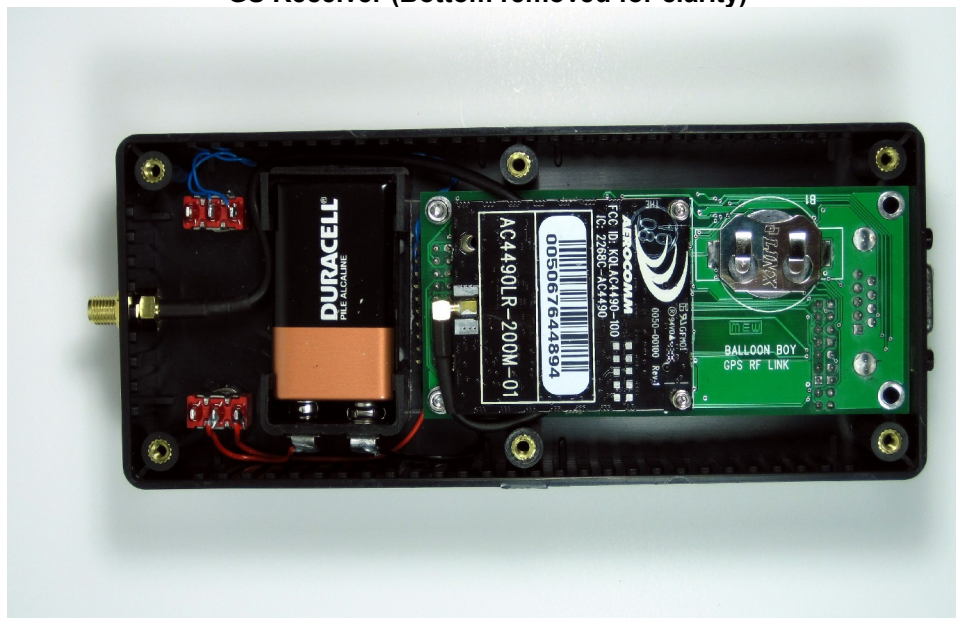
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### 5.6 Example Ground Station and Airborne Package systems integration

#### 5.6.1 Ground Station Receiver and Hand Held Yagi Antenna

GS Receiver (Bottom removed for clarity)



6 dBi GS Directional Yagi Antenna





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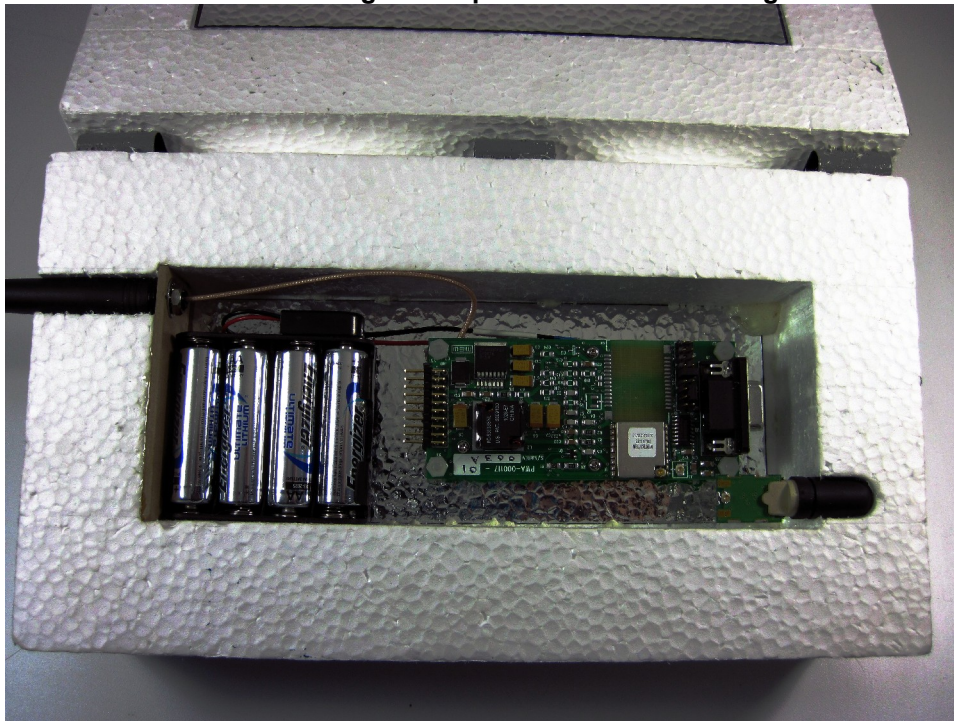
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### 5.6.2 Example Airborne Package system integration

Airborne Package In Preparation for Balloon Flight



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### 5.7 Balloon Boy Jumper Configurations:

This section details some of the possible jumper configurations used to configure BB GS and AP. Other combinations may be incompatible and cause conflict or hardware damage. Other possible jumper settings not detailed in this section should be thoroughly reviewed for functionality before physical implementation.

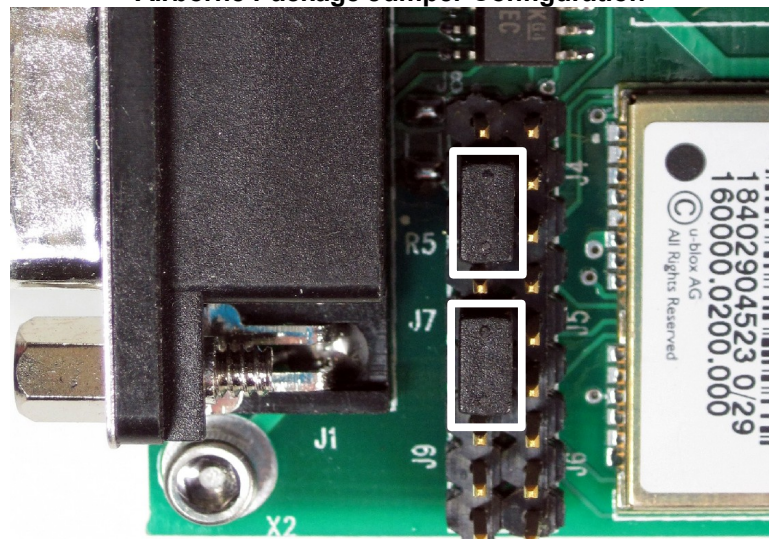
#### 5.7.1 Airborne Package Jumper Configuration

This Jumper configuration connects the GPS module TTL UART transmit and receive signal lines to the RF modem UART for over the air transmission. The configured Baud rate of the two modules must match. The Baud rates of the two modules cannot be adjusted using the Serial Com Port (J1) or configured when the AP is in this jumper configuration. When Balloon Boy is shipped the configured Baud rates are as follows:

AP using Inventek GPS receiver: 4800 Baud, 8 data bits, 1 stop bit, and no parity. (8-N-1)

AP using U-Blox GPS receiver: 9600 Baud, 8 data bits, 1 stop bit, and no parity. (8-N-1)

**Airborne Package Jumper Configuration**



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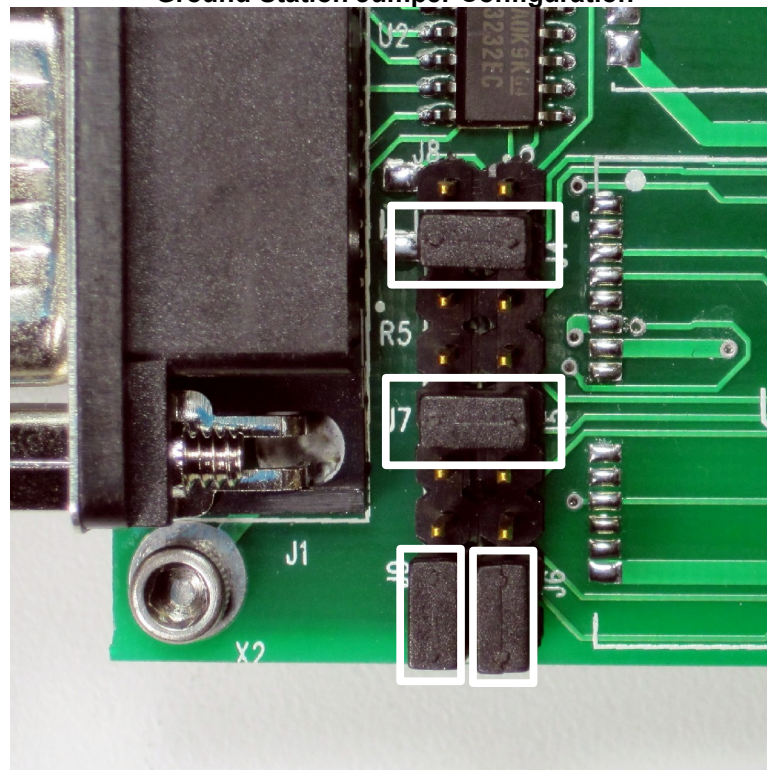
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### 5.7.2 Ground Station Jumper Configuration

This jumper configuration connects the RS-232 com port (J1) with the RF modem. The default baud rate as shipped is 4800 Baud (8-N-1), unless the Ground Station has been paired with a U-Blox equipped Airborne Package, in which case it will be configured for 9600 Baud, (8-N-1).

This jumper configuration is also used to configure the RF modem using a Personal Computer running Windows OS and Laird Technology configuration software. A link to this software download is referenced in section 6.1.

**Ground Station Jumper Configuration**





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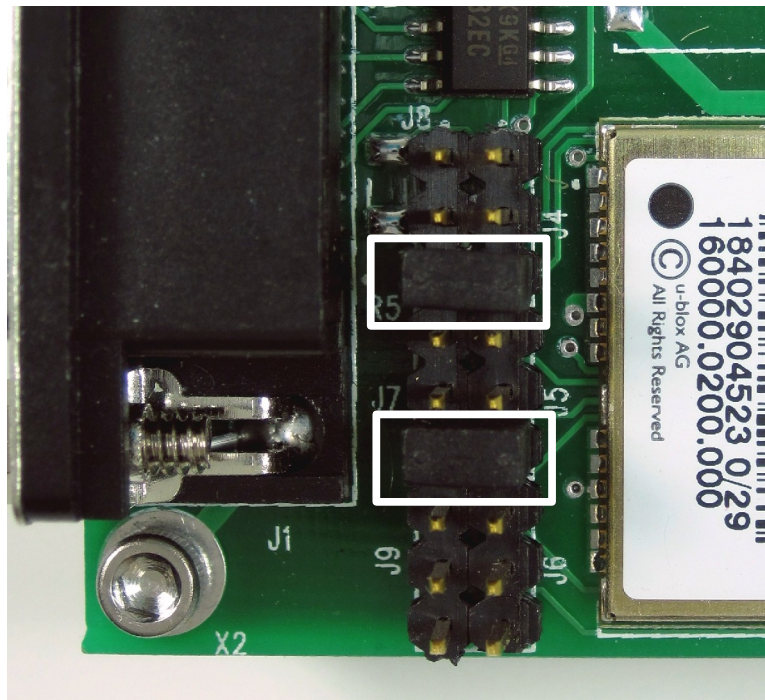
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### 5.7.3 GPS Module Jumper Configuration

This jumper configuration is required to configure the U-Blox GPS module. The default Baud rate as shipped is 9600 Baud (8-N-1). Configuration is performed using U-Blox U-Center software running on a Windows Personal Computer. The down load link for this software is listed in section 6.3.

#### GPS Jumper Configuration





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## 6.0 Third Party Reference Documentation

Configuration change, testing and verification of the BB Airborne and GS systems is implemented through use of the following documentation and configuration software:

### 6.1 Laird Technologies configuration software:

[http://www.lairdtech.com/downloads/Developer\\_Kit.zip](http://www.lairdtech.com/downloads/Developer_Kit.zip)

Laird Technologies AC4490 User Manual:

<http://www.lairdtech.com/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=2547>

### 6.2 Inventek Systems ISM300F2-C5-V0004 GPS module specifications:

<http://www.inventeksys.com/html/ism300f2-c5-v0004.html>

### 6.3 U-Blox LEA-6H GPS module specifications, documents and configuration software:

<http://www.u-blox.com/en/download/documents-a-resources.html>

<http://www.u-blox.com/en/evaluation-tools-a-software/u-center/u-center.html>

### 6.4 Visual GPS Windows freeware:

<http://www.visualgps.net/>

## 7.0 Disclaimers

MEW® is a registered service mark of MEW. LLC. All other referenced trade and service marks are the sole property of their respective owners.

MEW LLC assumes no liability from use, misuse, or misapplication of the equipment referenced in this document. The equipment referenced in this manual is specifically prohibited from use in human life support, medical, and/or health and safety critical systems or paths.

Design change, product enhancement and specifications are subject to change without prior notice at any time at the sole discretion of MEW, LLC.

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### 8.0 “No Double Speak” Warranty

Mew LLC will repair or replace end user hardware that has been shown to be defective from the factory for a period of one year from delivery of product. End user must request a Return Goods Authorization (RGA) from MEW LLC prior to shipment or delivery of defective material. Warranty does not cover material that has been damaged from shipping, dropping, ballistic earth impact, EOS, ESD, physical damage due to negligence, fire, water, moisture, exceeding the environmental, or electrical specifications.

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### 9.0 Document Revision History

Revision	Date	Changes	Authorization	CC&BW
NC	26NOV10	Initial draft for review	D.M.B.	J.E.B.
A	14DEC10	Corrected photo in sec 5.7.2	D.M.B.	J.E.B.